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Canada

FINAL REPORT

RESIDENTIAL TRAINING & RETROFIT PROJECT

REMOTE COMMUNITY DEMONSTRATION PROGRAM

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REMOTE COMMUNITY DEMONSTRATION PROGRAM

DECEMBER 1988

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1.0 Executive Summary

Using minimal resources and materials and with limited training, local carpenters/handymen can effect considerable change to their northern community housing, both in homeowner comfort and energy consumption.

2.0 Introduction

Energy conservation in the 1980's has become a common and accepted target throughout North America. Certainly, through the mediums of television and radio, the concepts and concerns are familiar to everyone. In remote Northern Saskatchewan, the term "Energy Conservation" is known. But, is it understood? Is it relevant? Do the residents have the knowledge and means to improve efficiency? These are the areas to which this project was dedicated.

Energy, Mines & Resources Canada, through Phase I of the Remote Community Demonstration Program, identified deficiencies in Northern housing. These identified deficiencies prompted the residential training and retrofit project as Phase II of the Remote Community Demonstration Program in Saskatchewan.

3.0 Goals and Objectives

The major goal of the project was to facilitate the learning and application of energy efficient retrofit measures and

safe, efficient wood burning practices in (5) five remote northern Saskatchewan communities. As well, the project sought to demonstrate the benefits of employing these measures, namely, a more comfortable and healthier living environment.

4.0 Methodology

The project was split into three (3) Phases.

Phase I, Training;

A resident of each participating community, selected by the local council, attended a two-week training course on retrofitting for energy conservation and wood heat safety. See Appendix A, Annex A, Statement of Work.

Phase II, Retrofit;

One demonstration home in each participating community, selected by the local council, was retrofitted by the local trainee, the project manager and an Energy, Mines and Resources Canada, Conservation and Renewable Energy Office, Technical Officer.

Phase II, Monitoring;

The project manager, using local trainees, organized a monitoring program of the retrofitted homes. The monitoring was to be done for one year following the completion of

retrofit work. See Appendix A, Annex A, Statement of Work.

Phase III, Follow-up;

Saskatchewan will assist participating communities to have local trainees perform moderate retrofit measures on other homes in their communities.

5.0 Results

5.1 Phase I, Training;

The training course was held at the West Side Community College, Beauval, in Northeastern Saskatchewan. It ran from October 20, 1986 until October 29, 1986 with (8) eight students from (5) five northern communities.

Training followed, with a few minor exceptions, the schedule as listed in Appendix A, Annex A, Statement of Work.

5.2 Phase II, Retrofit;

The Retrofit work took place in (2) two time periods. The first from July 16, 1987 to July 23, 1987 and the second from August 11, 1987 to August 17, 1987. Six homes were selected, three (3) from "Non-Status" northern communities and three (3) from northern Reserves.

The actual retrofitting work encountered a major set back immediately, in that the original subcontractor of Phase I

could not be engaged to complete Phase II.

This necessitated finding and contracting someone proficient in the industry, knowledgeable of the geographic area, and whose other commitments allowed sufficient time to successfully complete the retrofitting stage. The person selected was Mr. Robin Adair, of Wood N' Windowplace, Saskatoon.

Mr. Adair entered into a contractual agreement with Saskatchewan Urban Affairs to complete the retrofitting work and conduct monitoring within the periods set out in the Canada/Saskatchewan Residential Retrofit Project Agreement. He assembled the materials and tools required in the work and proceeded to the work site. The second set back occurred at this point. Nine of the ten persons trained in Phase 1 could not or would not participate in the second phase. This resulted in a delay while Mr. Adair located new, but untrained personnel.

From this point, the actual retrofitting work proceeded quite well, albeit somewhat slower than had been projected. Each home retrofitted was tested in accordance with the following schedule:

1. Air leakage ratios were tested before and after the retrofit work.

2. Radon gas levels were tested. (Two homes could not be tested).

3. Formaldehyde levels were tested.

4. Moisture probes were conducted.

5. Back draft and smoke pencil tests were performed, both during depression tests and under normal circumstances.

6. Temperature and humidity levels were determined.

All work was completed by August 17, 1988, and the continuing monitoring process had been established with the local residents whose homes had been retrofitted.

Retrofitting followed the schedule as listed in Appendix A, Annex A, Statement of Work.

5.2.2 Phase II, Monitoring;

Follow-up data from the monitoring process has been difficult to obtain. The importance of longer term testing results to compile a substantive evaluation profile is not readily

understood by many of the residents in these remote communities. As a result, readings are somewhat hit and miss, but do provide a composite of the conditions before and after. By caulking, weather stripping, and sealing windows with clear plastic, the average household air changes per hour were reduced from 7.21 to 6.20. Smoke pencil tests conducted on windows, doors, baseboards, and electrical outlets indicated an improvement from the bad/poor category to the fair/good range. New, efficient wood burning stoves were installed and immediate results were noted by these households in the reduction of solid fuel consumption. Although this latter item is difficult to quantify because results cannot be measured against any recorded data from prior years, the general indicators are fairly conclusive that inside temperatures were maintained at normal levels on less fuel.

The Nova Scotia Department of Mines and Energy, Municipal Air Sealing Project, suggests "air leakage" as being responsible for 40% of a home's heat loss. It also extrapolates that the per cent reduction in E.L.A., equivalent leakage area, divided by two "obtains a reasonable estimate of potential energy savings". This is based on Nova Scotia costs with more efficient heating systems, less costly fuel and some fuel consumption for domestic hot water.

This ratio of E.L.A. to energy savings is no doubt applicable to the "Residential Training and Retrofit Project".

For the six homes, the average reduction in E.L.A.'s divided by two is approximately 10%. Therefore, it is safe to assume energy cost reductions of this amount.

See Appendix E, Final Report, Municipal Air Sealing Project.

5.3 Phase III, Follow-up

Future northern community retrofits, using project knowledge acquired, will be encouraged by the Saskatchewan Department of Urban Affairs.

6.0 Conclusions and Recommendations

From the onset, it became apparent that ending up with the degree of technical data that was anticipated from retrofitting might prove difficult. What also became apparent was that a very substantial profile of basic housing construction in the North would emerge and more than compensate for any unretrievable data. In some homes the deficiency level noted was sufficient to distort what might otherwise have represented average evaluation readings.

The Phase I training module commenced on schedule and came

off reasonably well. The instructor made some excellent observations of the class and provided insight into how future classes could be restructured to optimize results. Specific recommendations included:

1. Providing more than three days to cover the considerable subject matter.

2. An assistant, to help with either the classroom presentations or the on-site demonstrations.

3. Reducing the classroom setting to 30% and increasing the hands-on time correspondingly to 70% would prove beneficial to northern residents.

4. An understanding of northern peoples' values, backgrounds, and learning experiences is fundamental to selection of instructors.

5. Availability of handout material would reduce class time and be less stressful to persons with marginal reading skills.

6. The course material and texts were informative and very

appropriate.

7. Class locations, where availability of materials, tools and photocopy facilities is a factor, should be considered.

The retrofit module had some logistical problems, but a considerable amount of information about northern housing construction was collected as a by-product of the home inspections and testing. Some of the homes had basic problems which could not be fully addressed by a retrofitting program, including:

1. Ceilings which contained below standard quantities of insulation. One home had a partially uninsulated ceiling.

2. Crawl spaces which were not insulated on the perimeters.

3. Floor joists and grade beams which were not insulated. Floors had holes.

4. Electrical outlets on exterior walls which were not enclosed in plastic.

5. Doors and windows which did not fit properly or which

had broken glazing.

6. Furnace heat ducts which ran through uninsulated crawl spaces.

These types of deficiencies are not beyond rectifying even now, and should probably form the first level of any future program before retrofitting is commenced. Correction of primary heat loss sources is paramount to obtaining an accurate profile of retrofitting results.

The Phase II monitoring module proved to be the most difficult component of this project. Because seven out of eight trainees no longer resided in the communities and "on the spot trainees" and homeowners were enlisted by the project supervisor, substantial energy consumption data collection was negated.

However, comments from homeowners about the excellence of the wood stove installations, increased comfort levels and less wood consumption reveal appropriate project results.

The Phase III, follow-up module will undoubtedly be easily carried out. Of the people originally trained, some have returned and "on the spot" trainees still reside in the communities. This means personnel are available, when this

aspect was the most difficult of the project.

The Residential Training and Retrofit Project, under the Remote Community Demonstration Program of Energy, Mines and Resources Canada, was a success. Using minimal resources and materials with limited training, local carpenters/handymen affected considerable change to their northern community housing both in homeowner comfort and energy consumption.

7.0 References and Acknowledgements

The authors of this report would like to thank Energy, Mines and Resources Canada for their invaluable assistance in the realization of this project.

CMHC — Training in Housing Rehabilitation Skills

R2000 — Super Energy Efficient Housing Program Builder's Manual

CSA — B365 Installation Code for Solid Fuel Burning Appliances and Equipment

Alberta/Canada

Energy Resources
Research Fund A survey of air leakage in Calgary homes, Bill Johnston Architect Ltd.

Energy, Mines
& Resources Canada
Draftstop, Evaluation of Durability and Replication Potential

Residential Energy Programs, Nova Scotia
Department of Mines & Resources
Final Report, Municipal Air Seal Project

APPENDICES

APPENDIX A

THIS IS ANNEX "A" TO AN AGREEMENT BETWEEN
ENERGY, MINES AND RESOURCES CANADA
AND SASKATCHEWAN URBAN AFFAIRS
MADE AS OF THE 14th DAY OF January, 1987

STATEMENT OF WORK

1.0 Objectives

To facilitate the learning and application of energy retrofit measures and safe efficient wood burning practices in the Northern Settlements of Stony Rapids, Kinoosao and Garson Lake, and the Northern Hamlet of Southend. As well, the project will demonstrate the benefits of employing these measures, namely, a more comfortable and healthier living environment.

2.0 Project Management

The following parties shall constitute the project management committee:

- Project Officer, Conservation and Renewable Energy Office, Energy, Mines and Resources Canada, Saskatoon
- Director, Northern Services Branch, Saskatchewan Urban Affairs, La Ronge
- Principal, West Side Community College, Beauval
- RRAP Representative, Saskatchewan Housing Corporation, Prince Albert
- Program Officer, Saskatchewan Employment Development Fund, Prince Albert

3.0 Project Description

3.1 Stage One - Training Course (Fall 1986)

On behalf of the communities name below, Saskatchewan shall cover instructional cost incurred by the West Side Community College, in retaining a qualified person to prepare and instruct in Buffalo Narrows a two-week training course on residential energy retrofit and wood heat safety. The local councils of the Northern Settlements of Stony Rapids, Kinoosao and Garson Lake, and of the Northern Hamlet of Southend and of the Bands at Southend, Fond-du-Lac and Black Lake shall select one local carpenter/construction crew member to attend the course hereinafter referred to as the "local trainee". The course shall be based on the following existing training materials and reference documents:

Training Course Materials:

- CMHC Training in Housing Rehabilitation Skills, Course 3, Energy Conservation in Rehabilitation, 1982.
  Module 1: The Assessment of Existing Conditions (83 p. manual)
  Module III: Retrofit Measures and Materials (122 p. manual)

- Building Energy Awareness for Band Housing Co-ordinators, Yukon CREO, Fall 1985, (46 p. seminar manual)

- Skookum Jim Friendship Centre Retrofit Training, Canada (Yukon CREDA, August 1984 (32 p. training manual) and video.

- R-2000, Super Energy Efficient Housing Program Builder's Manual (one volume) and Instructor's Handbook (two volumes)

- The "House as a System" Workshop Material Trainer's Kit (March 1986)

Reference Documents:

- Heating With Wood, Energy, Mines and Resources Canada, 1986 (18 pages)

- Installation Code for Solid Fuel Burning Appliances and Equipment Fire Safety and Fuel Burning Equipment, Canadian Standards Association, August 1984 (42 pages)

- The Billpayer's Guide to Heating Systems, (Chapter 7: Heating with Wood, Chapter 8: Chimney and Ventilation Systems), Energy, Mines and Resources Canada, June 1985 (81 pages)

- "Wood Burning Appliance Regulations", Energy, Mines and Resources Canada, August 1986, (3 pages)

- 1985 Solid Fuel Appliance Catalogue, Energy, Mines and Resources Canada (55 pages)

Half of each day shall be spent in the classroom and half in a workshop or local house.

WEEK ONE - Retrofit of Existing Housing

Topics covered shall be:

- materials and tools
- flooring systems
  - air vapour barriers
  - cantilevers
- retrofit framing
  - partition walls
  - air vapour barriers

- insulation
  - summary of existing types
  - retrofit situations
- air vapour barriers
- humidity and ventilation
- monitoring humidity

WEEK TWO - Wood Stoves and New Construction

Monday and Tuesday: Wood stoves
- chimney cleaning
- wood burning appliance technology
- wood heat practices and safety

Wednesday to Friday: New construction
- energy efficient construction techniques
- insulation and air-vapour barriers
- ventilation

Upon completion of the course, Saskatchewan shall provide a detailed curriculum as prepared by the instructor and course evaluation satisfactory to Canada.

3.2 (a) Stage Two - Retrofitting (Spring/Summer 1987)

The instructor shall help the local trainee retrofit one demonstration house in each non-status community of Stony Rapids, Kinoosao and Southend, and in each status community of Southend, Fond du Lac and Black Lake.

Saskatchewan shall arrange for the instructor to identify and order materials needed for retrofits, and to oversee/participate in the retrofit work.

The retrofit work to be undertaken in each house, depending on the needs of each house and the wishes of the community, shall include:

i) Caulking wall-cracks, baseboards, door and window trim

ii) Installing gaskets and safety plugs in electrical plug and switch gaskets.

iii) Weatherstripping opening windows

iv) Installing plastic storm windows INSIDE the window frame

v) Increasing attic insulation from RSI 3.5 to RSI 7.0 (R40)

vi) Installing a metal clad insulated door and frame (3.0 foot width)

vii) Installing a fire extinguisher (5 lb. ABC)

viii) Installing a smoke detector (battery operated with light)

ix) Installing a wood cookstove or other upgraded airtight wood burning appliance (approved in advance by Canada)

3.2 b) Stage Two - Monitoring

Saskatchewan shall arrange for the instructor to organize a monitoring program of the retrofitted homes. In supervising the monitoring, the instructor shall use the local trainees to obtain data. The instructor shall have the data analyzed by the Ontario Research Foundation. The monitoring shall be for one year following the completion of retrofit work and shall be completed by August 31, 1988. It will include the following measurements, taken at the frequencies indicated.

	MEASUREMENT	FREQUENCY
1.	Depressurization test - A blower door shall be used to measure the change in air tightness	Immediately before and after retrofit
2.	Radon gas - A radon pump and analysis shall be obtained from the Ontario Research Foundation (ORF)	Before retrofit and at end of monitoring period
3.	Formaldehyde - The monitoring device and analysis shall be obtained from the ORF	As above
4.	Nitrogen dioxide - The monitoring devices and analysis shall be obtained from the ORF, to test whether tightening the house has induced combustion exhaust back-drafts (i.e. - from a wood stove)	Once - immedi tely after monitoring
5.	Moisture probe - Building deterior-ation due to moisture shall be assessed by inserting Delmhost moisture probes in several studs	Before retrofit and at end of monitoring period
6.	Back draft and air leakage - Smoke pencil tests	Before retrofit and monthly during mon-itoring period

7.	Temperature and humidity - A sling psychrometer shall measure the crawl space, living space and attic humidity level and temperature, and outdoor temperature	As above
8.	Occupant interviews - A brief questionnaire shall cover life-style information required for data interpretation, and gauging occupant satisfaction	As above

3.2 (c) Stage Two - Project Report

On completion of Stage 1 and Stage 2 (a) and (b), Saskatchewan shall provide Canada with a report on the project, accompanied by a course outline. The Report shall indicate the usefulness of the course materials provided by Canada, and shall describe the stages of the project, the objectives of the project, the experiences under each stage, conclusions and recommendations. Saskatchewan shall provide Canada with a draft final report and shall take Canada's comments into consideration before providing the final report. The final report shall be on plain white 8½" x 11" paper, typed single spaced, with extra space between paragraphs.

3.3 Stage Three - Other Retrofits

Saskatchewan shall help the Northern Settlements/Hamlet complete applications under Saskatchewan Housing Corporation's Residential Rehabilitation Assistance Program (RRAP) and under the Saskatchewan Employment Development Fund (SEDF). With funding from RRAP and SEDF, in the employ of his/her community, the local trainees from Stony Rapids, Kinoosao and Southend will perform moderate retrofit measures on other homes in their communities. The measures will likely include items (i) to (v) under section 3.2 as well as squaring the outer door, tightening the latch, installing weatherstripping and threshold sweep.

APPENDIX B

INSTRUCTOR'S REPORT

RETROFIT AND WOOD HEATING COURSE

RESIDENTIAL TRAINING AND RETROFIT PROJECT

REMOTE COMMUNITY DEMONSTRATION PROGRAM

OCTOBER 1986

Conservation and Renewable Energy Office
Energy, Mines and Resources Canada
Saskatoon, Saskatchewan

REMOTE COMMUNITY DEMONSTRATION PROGRAM

RESIDENTIAL TRAINING AND RETROFIT PROJECT

RETROFIT AND WOOD HEATING COURSE

The course started October 20 and continued through October 29, 1986. There were 8 students from 5 communities.

Dickie Clark	Southend (Band)
George Bird	Southend (Band)
Randy McKenzie	Southend (Band)
Albert Thomas	Southend (Hamlet)
George Olsen	Kinoosao
Napoleon Mercredi	Fond du Lac
Francis Denazie	Black Lake
Gerald Kasyon	Stony Rapids

1. INSTRUCTOR'S EVALUATION

The actual development of this course, to meet the specific needs and interests of native students, entailed considerably more time than the three days allowed. As well, there were many occasions when an assistant would have been more than helpful. Attending to the many details, both physical in the building and retrofit work, and academic in the daily tailoring of the curriculum, left me feeling spread quite thin.

Fifty percent classroom time is, in my opinion, too high. None of the students come from academic backgrounds. The formal or structural classroom setting of three hours or more a day wears at the patience of most native students. Thirty percent classroom time and seventy percent hands on learning would be more appropriate. By interjecting building science concepts during the hands-on sessions, the instructor can accomplish many of the aims of formal classroom training without encountering student resistance.

Building experience amongst the students varied widely. Two students had five years of carpentry, two had two years, while one had only a year as an apprentice. Three of the students, from Southend, were beginners, having completed a six week course at the start of the summer. Two of these three were the keenest learners. Since a good deal of the material was new in this course, attitude towards learning was of as much or more value than experience.

All of the tactics which serve to capture the interest of southern audiences, often fail in the north. Much of the positive feed-back, both verbal and non-verbal, which many speakers and lecturers come to expect, can be unnervingly sparse. One cannot heap fact upon fact even if a conceptual base is layed for an understanding and assimilation of those facts. Much interjection of the speakers personal experience, and analogies familiar to the audience, are needed to sustain interest. Conventional lecturing techniques can be a waste of time and an exercise in futility. None of the students were raised with lecturing as the main form of instruction. Much of their experience with learning is through observation and doing. As well, the students must be allowed time to know and, hopefully, like the instructor, before a give and take discussion can occur.

This is not to say the students read poorly. Most had a grade nine reading level and if I had had enough time, and access to a copying machine, I would have duplicated a fair amount of material as hand outs. The total newness of the R-2000 material caused an information overload. Hand-outs relevant to the course could have been taken home and digested more slowly.

Three of the students are Chipweyan; the other five are Cree. These people speak different mother tongues, sharing only English, which a number of them are not too comfortable using or listening to. Whatever the class was doning, there was always a group of three Chipweyans and a group of five Cree. For hands on work, this always meant two separate work groups and often, two separate projects. There was no hostility but rather an aloofness from one another that made the class seem split. This experience might be helpful in grouping another class.

I could have done a better job with less effort had the course been offered in La Ronge, rather than Buffalo Narrows. All my tools and interpersonal connections are there. I would have had access to any number of building sites and homes for demonstrations purposes. In Buffalo Narrows, I am a stranger. La Ronge Community College also has a proper shop whereas West Side Community College has closed theirs. The tool situation for the course was barely adequate.

2. TRAINING COURSE MATERIALS EVALUATION

Both Modules I and III of CMHC's Training in Housing Rehabilitation Skills were excellent. Both modules directly addressed the "Residential Retrofit" part of the course title in an organized and thorough manner. I often wished I had had the other modules in the set.

Building Energy Awareness for Band Housing Co-ordinators (Yukon CREO) would have been a good hand-out manual for taking home. As I had no access, because of time, to a copying machine, this manual was little used. Much of its information is found in other sources which I covered in class.

The Skookum Jim Friendship Center Retrofit Training manual and video (Yukon CREO) would get similar comments to the above. The video was good because it showed natives, like themselves, successfully doing retrofit work. Although the quality of the video was poor, the students related to the medium. One stand out item in the Skookum Jim manual was the section on the fabrication of plywood and structural lumber floor joists which is very applicable to the far north.

The R-2000 Builders Manual and Instructor's Handbook contained a good deal of relevant information. However, due to the shortness of the course and the students lack of experience with R-2000 type building procedures, only the main features could be touched upon. I found the R-2000 slide shows, used with my own comments and drawings, more appropriate.

The "House As A System" workshop material trainer's kit, gets good marks for its relevancy. However, I lacked the time to do it justice. I used it mainly to illustrate principles of building science.

Heating with Wood was very approachable for the students and the most assimilated when used in conjunction with the Wood Heat slides and discussion.

Installation Code for Solid Fuel Burning Appliances and Equipment was clear in showing safe and legal clearances between stove and chimney parts, and combustible surfaces. This area was heavily stressed as a number of the students had direct experience with wood heat house fires, one involving loss of life.

The Billpayer's Guide to Heating Systems had a lot of material only relevant to the south. However, distribution systems for heat and the major types of wood burning stoves were shown very well.

The 1985 Solid Fuel Appliance Catalogue was well put together but of little interest to the students as all had wood stoves installed at home. This is the type of publication that is needed on more energy efficient products.

The Wood Burning Appliance Regulations was encompassed by Installation Code for Solid Fuel Burning Appliances and Equipment. It would have made a good hand out.

3. COURSE OUTLINE

DAY 1

- Introduction of course materials to be presented.
- Found out each student's construction experience and expectations from the course.

- Showed overhead slides (from EMR's Point of Sale seminars) which covered basics of building science.

- As English is a second language to all of these students, I had to slow the pace for explanations of concepts like convection and conduction.

- Started on CMHC's Training in Housing Rehabilitation Skills Module I, "The Assessment of Existing Conditions", and spent the rest of the morning explaining, drawing, and sometimes repeating points that were new or hard to grasp.

- Spent first part of on-site inspection walking around perimeter of community college bungalow built in mid-1970s. Discussed the construction flaws and general neglect which have led to certain structural problems.

- Talked about direct energy heat loss (like unsealed wall penetrations) and indirect effects on heat loss (like foundations that heave and undo retrofit work).

- Followed a similar procedure inside the house where we found a host of mistakes like insulated headers with no vapour barrier. Talked about remedial measures.

- Went over all the caulking, sealing, weatherstripping and insulating samples from EMR's Point of Sale seminars. Passed samples around and gave examples of their applications.

- Showed videos of Skookum Jim Retrofit and Double EE Retrofit and discussed details.

DAY 2

- Salesman for Ansul fire extinguishers gave lecture on many aspects of fire safety equipment, fire suppression techniques and the physics of fire itself.

- Learned how to suppress chimney fires and choose appropriate extinguisher and were made aware of the electrical dangers of fighting fires associated with wood heat.

- Each student had excellent hands-on experience with suppressing real fires.

- Although I had intended to leave the wood heat safety part of the course until later, I felt the opportunity of this lecture and hands-on experience too good to pass up.

- Spent the afternoon going over more slides from EMR's Point of Sale seminars and discussed each in detail, often turning on the lights and sketching details on the chalk board.

- Continued on with examination of retrofit materials which related to the slide show. Talked about pros and cons of various insulation types.

DAY 3

- Continued on with Module I, "The Assessment of Existing Conditions" and noted a better flow of give and take discussion.

- Showed more slides of existing homes being retrofitted, stopping often to draw on chalk board.

- Continued stressing importance of indirect effects on heat loss such as improper drainage and flashing as they relate to the on-going integrity of the structure.

- Showed Double EE Retrofit video again as the information is well presented and very relevant but moved along too fast for most students the first time through.

- Shopped at hardware store with list for retrofit materials which was instructive as many students had never had the experience.

- Removed baseboards, door and window trims and caulked with laytex arcylic where space was tight and injected foam where space would allow. Caulking was awkward for most students at first and none had used foam caulking before.

DAY 4

- Continued with discussion of building envelope in Module I as it relates to calculation of R or RSI values and thermal bridging for each envelop component.

- Identified standard electrical, plumbing and vent openings in the house envelop to use for inspection purposes.

- Stressed the need for not getting side tracked into problems unrelated to energy conservation while inspecting.

- Discussed building site and its effect on solar gain, wind protection and drainage and gave a number of examples of good and poor site situations.

- Covered proper placement of deciduous and evergreen trees for shade in summer and wind protection in winter.

- Gave more examples of house and site problems, seemingly unrelated to energy conservation, that ultimately affect retrofit work.

- Started Module I (The Building Exterior) of CMHC's Training in Housing Rehabilitation Skills Module I and preliminary inspection overview.

- Continued caulking and foaming. Installed weatherstripping around the attic hatch and bolts for tight seal. Stressed the need for a good job here, as it is not only a major heat loss area, but also a source of great moisture problems for the attic. Cut away excess dried foam and returned baseboards and trim. Caulked header joist area and installed pink insulation with vapour barrier. On the opposite wall, the students installed blue S.M. to try an alternative which proved to be far more to their liking.

- Demonstrated techniques and procedures for handling caulking and sealants which reduce mess and clean up time.

DAY 5

- Started with topic of basements, crawl spaces and foundation walls. Covered each one pint by point with examples and drawings as they related to heat loss. Discussed only the types of foundations that were relevant to the houses in northern communities.

- Talked about on-going foundation problems and how to monitor them for a season or two.

- Covered crawl spaces and floors over unheated spaces and emphasized the need for an air barrier on the old side of the insulation and the importance of not confusing it with a vapor barrier.

- Showed R-2000 slide show and video.

- Finished retrofitting of bungalow including the application of clear plastic film on the inside of every window. Discussed the common mistake of applying plastic to the outside of windows and the resulting condensation problems.

- Spent the rest of the afternoon making two walls which were the start of a small structure incorporating the details of strapwall construction suitable to "R-2000" standards. Details for continuity of vapor barriers with walls, doors, and windows, to be incorporated in days to come, as well as placement of wiring and electrical panel and outlets.

DAY 6

- Showed CREO slides on wood burning stoves and equipment and fire safety. Slides were discussed with relevant comments, questions and answers.

- Covered wood combustion science and creosote formation in depth as well as stove sizing, heat loops, heat shields and chimney fires.

- Clearances for factory chimneys, stoves, ducts and flues were covered in depth as well.

- Methods of gathering and drying wood as well as Btu output of wood species were discussed.

- Continued building strapwall structure.

DAY 7

- Showed more CREO wood heating slides and discussed them.

- Reviewed the fundamentals of the three stages of a fire and the temperatures involved in each stage and their relationship to creosote formation.

- Illustrated the pros and cons of the different major stove types and draft designs.

- Principle of catalytic combustors, both built-in and add-on, was discussed as well as the weak points and potential contamination of these devices.

- Installation of factory built chimneys was major topic with emphasis on safety and proper flashing procedures. Reviewed the types of factory built chimneys emphasizing the use of high temperature types for wood heat.

- Continued with strapwall building.

DAY 8

- No formal classroom theory today as the R-2000 structure must be completed before the end of this course. However, halts were called periodically when a particular construction detail was encountered that needed emphasis or required a more complete understanding of the building science principles involved.

- The strapping details for the baseboards, ceiling, electrical, and rough openings were completed with satisfactory results. The class continued on through the afternoon with no stops almost finishing the roof. Talked about flashing and overhangs and the avoidance of rot problems along the facia.

DAY 9

- Finished laying roofing materials. Started drywalling the interior of the shed. Many of the students were unfamiliar with proper muding, taping and drywalling procedures and showed particular interest in repairing broken sections of drywall. Repair of the vapour barrier under the broken section of drywall was stressed to protect the integrity of the building envelope from moisture damage.

APPENDIX C

SUPERVISOR'S REPORT

RESIDENTIAL TRAINING AND RETROFIT PROJECT

PHASE II

REMOTE COMMUNITY DEMONSTRATION PROGRAM

DECEMBER 1987

Conservation and Renewable Energy Office
Energy, Mines and Resources Canada
Saskatoon, Saskatchewan

REMOTE COMMUNITY DEMONSTRATION PROGRAM

RETROFIT PROJECT PHASE II

The work was done in two time periods. The first from July 16 to July 23 and the second from August 11 to August 17, 1987.

There were six homes selected from six communities, three from Indian Reserves and three from northern communities. The homes selected are as follows:

Cliff Morin - South End Indian Reserve

Rose Thomas - South End, Saskatchewan

Rod Clarke - Kinoosao, Saskatchewan

Ben McKenzie - Stoney Rapids, Saskatchewan

Martin Sayazie - Black Lake Indian Reserve

Edward Isadore - Fon Du Lac Indian Reserve

1. Evaluation

This phase of the project was intended to follow the Residential Retrofit Training and Wood Heat Safety Course held in Buffalo Narrows, Saskatchewan, October 20 - October 29, 1986. Those attending this course were to have helped the instructor to retrofit homes in their own community. However, the instructor could not follow through with the project, so the retrofit work was delayed until the summer of 1987 when Robin Adair took over his position.

Of the people trained, only one participated in the retrofit work in their community. The reasons given were forest fire fighting, other work located and loss of interest due to the time gap between course and retrofit work. The only trainee who did help did not seem too interested based on the fact that he had started another course in La Ronge, although he did participate in one home retrofit. Local help was obtained to do some work in the retrofitting for four of the houses. These local contacts may be helpful to complete monitoring on the buildings on a monthly basis.

2. Monitoring

i) Each house was tested for air leakage ratios before and after the retrofit work. The results will be set out in review of each house later in the report.

ii) Radon gas was tested for in four of the six houses done. One house had no electrical hook ups. The other house occupant did not want the pump as it made too much noise. Another test will be performed at the end of the monitoring period.

iii) Formaldehyde was tested for in each house, and will be tested at the end of the monitoring period.

iv) Nitrogen dioxide will be tested for after monitoring period.

v) Moisture probes were done (results in report) and shall be done again after monitoring period.

vi) Back draft and smoke pencil tests - done during depression tests, and under normal conditions - no back drafting found in any of the houses tested. Monthly testing results to come.

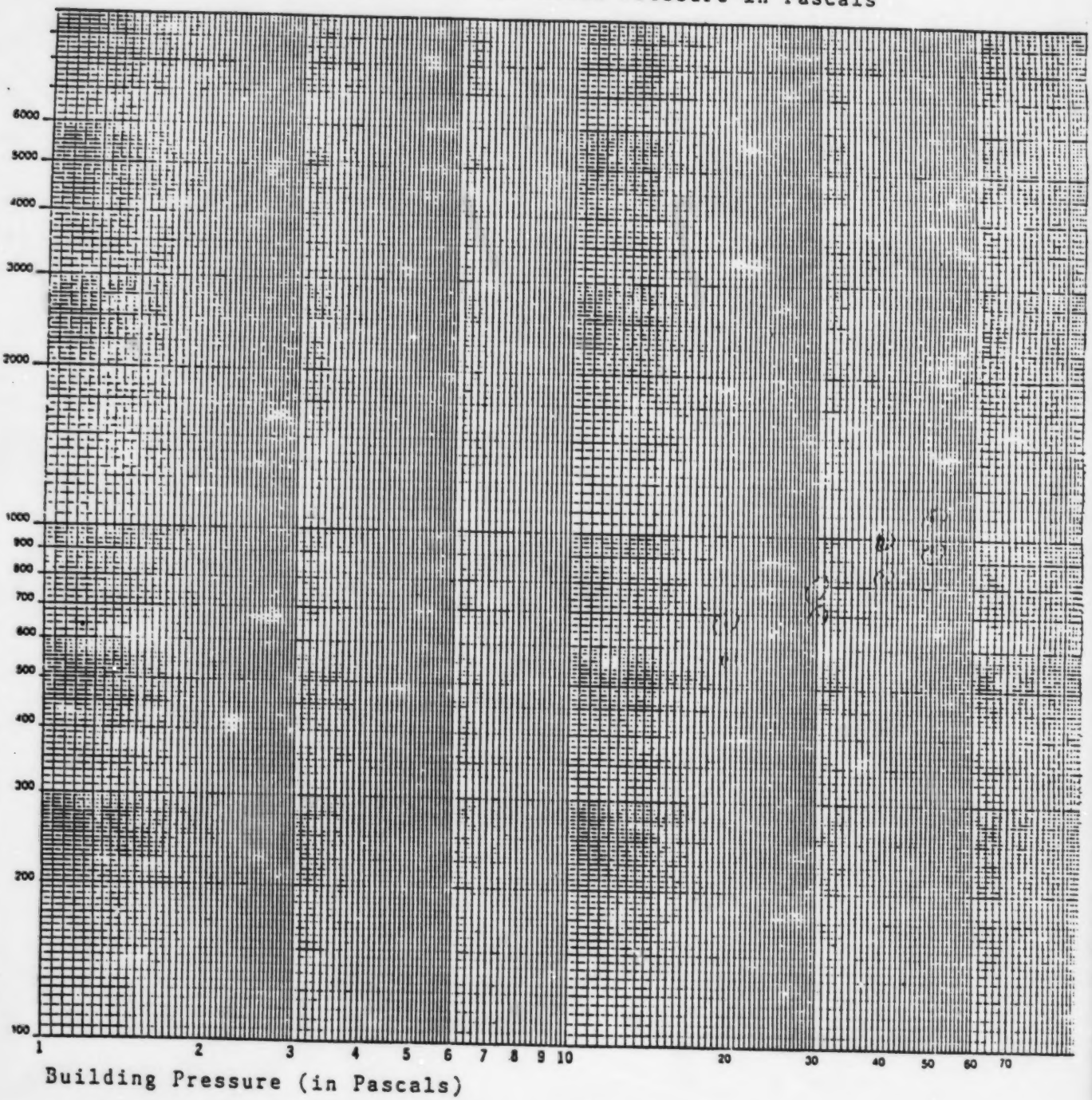
vii) Temperature and humidity tests done (results in report) - monthly results to follow.

viii) Occupant interview results in report.

ix) Due to poor trainee participation in the retrofit work, obtaining monitoring results has been very difficult. Questionnaires were left in each community with certain individuals who agreed to perform the questionnaire. Each house had 12 questionnaires ready for each month and 12 self addressed stamped envelopes ready for mailing.

BUILDING AIR LEAKAGE CURVE

Air Flow in CFM vs. House Pressure in Pascals



Logarithmic, 2 x 2 Cycles

APPENDIX B
1

Blower Door Air Leakage Test

Name Morin Date July/87

Address South End Outside temp. 66

Indian Reserve Inside temp. 68

Wind speed 10 km/hr

House Volume 6336 Cu. Ft. Surface Area 2576 Sq.Ft.

Fan Calibration	:Open Fan	Q (CFM)=385.0 X (P).473
Low Flow Plate:	0 holes plugged	Q (CFM)=101.0 X (P).486
	4 holes plugged	Q (CFM)= 71.7 X(P).454
	6 holes plugged	Q (CFM)= 38.3 X(P).469
	7 holes plugged	Q (CFM)= 24.4 X(P).465
	8 holes plugged	Q (CFM)= 14.18 X(P).477

Test #1

Pressurized ___ Depressurized X

P House (Pa)	P Fan (Pa)	low-flow plate # holes plugged	Flow (CFM)
50	130	0	1100
40	90	0	900
30	68	0	780
20	48	0	670

AC/H @ 50 Pa 10.42

Equivalent L.A. _____

Effective L.A. _____

Test #2

Pressurized ___ Depressurized X

P House (Pa)	P Fan (Pa)	low-flow plate # holes plugged	Flow (CFM)
50	100	0	950
40	740	0	840
30	55	0	700
20	37	0	570

AC/H @ 50 Pa 8.99

Equivalent L.A. _____

Effective L.A. _____

Comments (Condition of vents and flues during test, major leakage sites, recommendation, etc.).

FOUNDATION: Two stage - Existing - seemed O.K. outside.
WALLS: Perimeter NVB interior walls
WINDOWS: - Double Hung

- Blinders

AMSELM THOMAS: South End, Saskatchewan

1. Building type 14 year old toronto split 24 x 32 complete with front porch, preserved wood foundation with crawl space 12,288 cu. ft.

2. Condition Good condition except for front door needs replacement, some windows broken and covered up with plywood.

3. Heating System Oil furnace with ducting in crawl space and under floor joists, wood stove hooked directly to existing chimney of furnace (wood stove not properly installed).

4. Window area sq. footage 90 sq.ft.

5. Occupants Two adults and three children.

MONITORING

1. Depressurization Test - see attached sheet

2. Moisture probe - 10-13%

3. Back draft/smoke pencil - windows - poor
   - doors - poor
   - baseboards - good
   - electrical outlets - very poor
   - oil furnace - no back draft.

4. Temperature and humidity

	wet	dry	RH
- basement	60	67	68%
- living space	63	72	62%
- attic space	66	81	46%
- out door temp.	58	67	58%

5. Occupant Interview - Possible fire hazard on basement wood stove. No running water, plumbing or door locks.

Blower Door Air Leakage Test

Name Thomas Date July/87

Address South End Outside Temp. _____

_____ Inside temp. _____

_____ Wind speed _____

House Volume 12288 Cu. Ft. Surface Area 3328 Sq. Ft.

Fan Calibration :Open Fan Q(CFM)=385.0 X(P).473
Low Flow Plate: 0 holes plugged Q(CFM)=101.0 X(P).486
4 holes plugged Q(CFM)= 71.7 X(P).454
6 holes plugged Q(CFM)= 38.3 X (P).469
7 holes plugged Q(CFM)= 24.4 X (P).465
8 holes plugged Q(CFM)= 14.18 X(P).477

Test #1 Test #2

Pressurized ____ Depressurized X Pressurized ____ Depressurized X

P House (Pa)	P Fan (Pa)	low-flow plate # holes plugged	Flow (CFM)	P House (Pa)	P Fan (Pa)	low-flow plate # holes plugged	Flow (CFM)
60	102	0	950	58	75	0	825
50	82	0	860	50	60	0	750
40	67	0	780	40	47	0	660
30	44	0	640	30	35	0	570
20	27	0	500	20	20	0	438

AC/H @ 50 Pa 4.20 AC/H @ 50 Pa 3.66
Equivalent L.A. N/A Equivalent L.A. N/A
Effective L.A. N/A Effective L.A. N/A

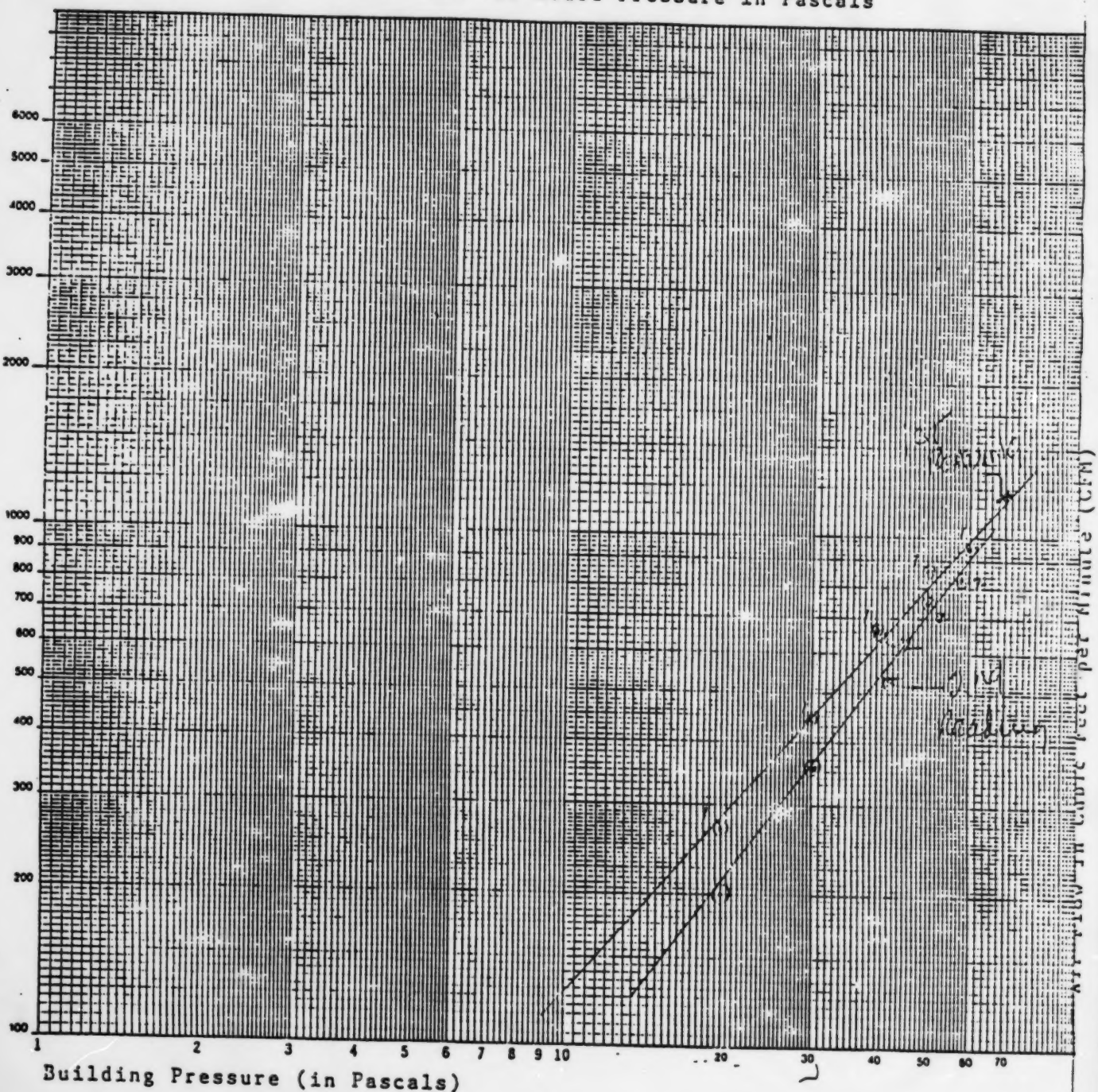
Comments (Condition of vents and flues during test, major leakage sites, recommendations, etc.).

Test performed by _____.

(HUGHES - SOUTH END)

BUILDING AIR LEAKAGE CURVE

Air Flow in CFM vs. House Pressure in Pascals



ROD CLARKE: Kinoosao, Saskatchewan

1. Building type 24 x 34 bungalow on concrete grade beam 6144 cu. ft.

2. Condition House in good condition.

3. Heating System Oil furnace, ducting routed through uninsulated crawl space, old wood stove had been removed prior to retrofit.

4. Window area sp. footage approx. 102 sq. ft.

5. Occupants Two adults and 6 children.

MONITORING

1. Depressurization test - see attached sheet.

2. Moisture probe - 10%

3. Back draft/smoke pencil - windows - fair
   - doors - very bad
   - baseboards - good
   - electrical outlets - very bad
   - furnace - no back draft

4. Temperature and humidity

	wet	dry	RH
- crawl space	NA	NA	NA
- living space	60	73	48%
- attic space	63	83	33%
- out door temp.	56	69	45%

5. Occupant Interview - Occupants away during retrofit work.

APPENDIX B
1

Blower Door Air Leakage Test

Name Clark — Date July/87

Address Kinoosao — Outside temp. 69°F

Inside temp. 73°F

Wind speed 5 km/hr

House Volume 6144 Cu. Ft. — Surface Area 2560 Sq. Ft.

Fan Calibration :Open Fan — Q(CFM)=385.0 X(P).473

Low Flow Plate:
- 0 holes plugged — Q(CFM)=101.0 X(P).486
- 4 holes plugged — Q(CFM)= 71.7 X(P).454
- 6 holes plugged — Q(CFM)= 38.3 X(P).469
- 7 holes plugged — Q(CFM)= 24.4 X(P).465
- 8 holes plugged — Q(CFM)= 14.18X(P).477

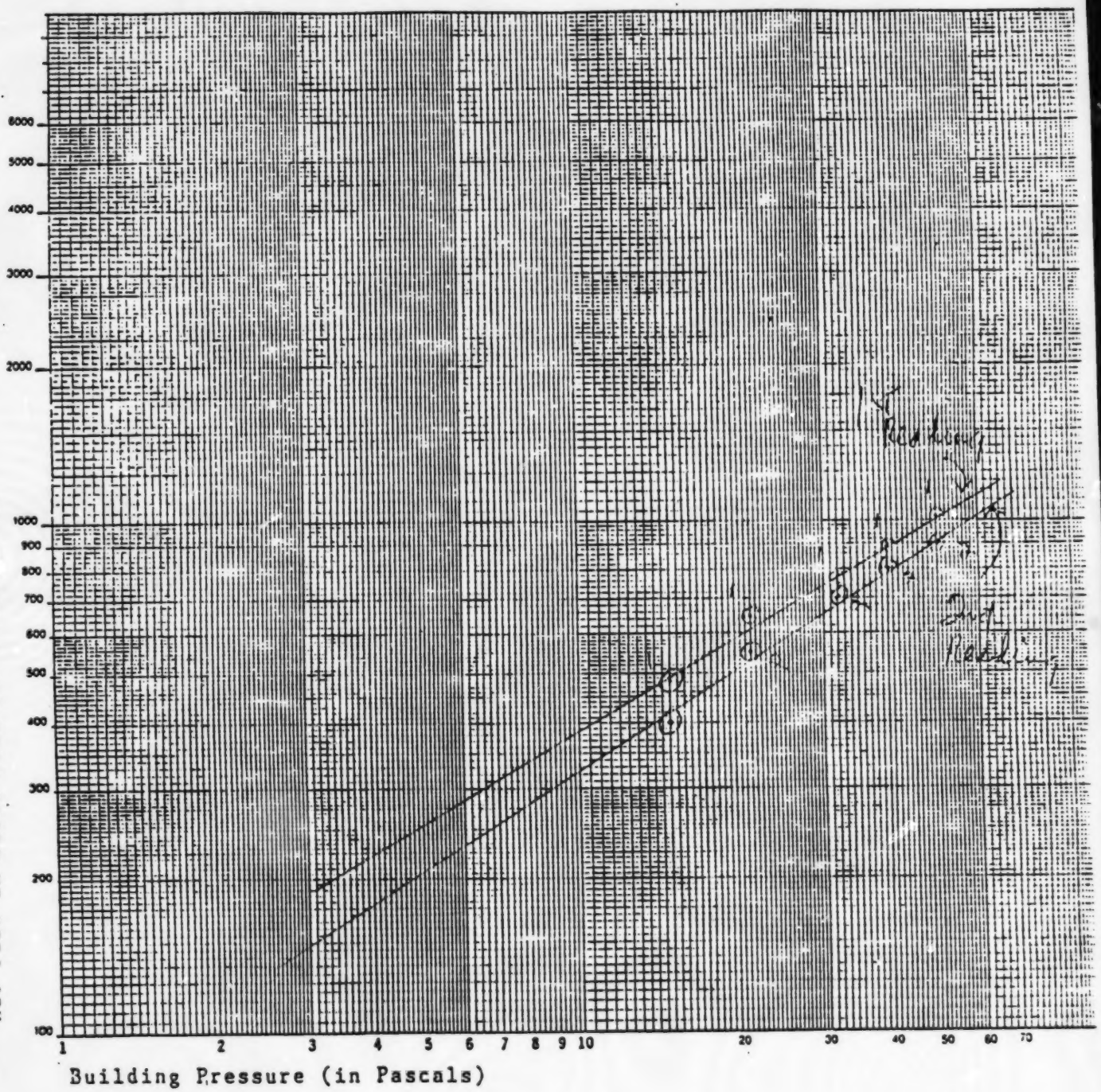
Test #1				Test #2			
Pressurized ____ Depressurized X (low-flow plate)				Pressurized ____ Depressurized X (low-flow plate)			
P House (Pa)	P Fan (Pa)	# holes plugged	Flow (CFM)	P House (Pa)	P Fan (Pa)	# holes plugged	Flow (CFM)
50	115	0	1020	50	90	0	900
40	87	0	890	40	70	0	800
32	65	0	775	32	55	0	700
23	45	0	645	23	33	0	550
15	25	0	480	15	17	0	400
AC/H @ 50 Pa		9.96		AC/H @ 50 Pa		8.79	
Equivalent L.A.				Equivalent L.A.			
Effective L.A.				Effective L.A.			

Comments (Condition of vents and flues during test, major leakage sites, recommendations, etc.)

Test performed by _____.

BUILDING AIR LEAKAGE CURVE

Air Flow in CFM vs. House Pressure in Pascals



BEN MCKENZIE : Stoney Rapids, Saskatchewan

1. Building type 13 year old toronto split, 24 x 32 complete with front porch preserved wood foundation with crawl space 12,288 cu. ft.

2. Condition Poor condition, no electrical hookup, windows broken, holes in drywall, front door no locks.

3. Heating system Oil furnace has not worked in years, small cook stove in kitchen not installed properly, which is the only heating source.

4. Window area sq. footage 90 sq. ft.

5. Occupants Four adults and one child.

MONITORING

1. Depressurization Test - see attached sheet.

2. Moisture probe - 8-10%

3. Back draft/smoke pencil - windows - very poor
   - doors - very poor
   - baseboards - poor
   - electrical outlets - very poor
   - oil furnace defunct.

4. Temperature and humidity

	wet	dry	RH
- crawl space	NA	NA	NA
- living space	60	73	48%
- attic space	63	84	32%
- out door temp	58	67	58%

5. Occupant Interview - Bad house, uninhabited and close to abandonment. Has no electricity, running water, door locks and a defunct oil heater in the basement.

Blower Door Air Leakage Test

Name McKenzie — Date August/87

Address Stoney Rapids — Outside temp. _____

_____ — Inside temp. _____

_____ — Wind speed 20 km/hr

House Volume 12,288 cu. ft — Surface Area 3328 Sq. Ft.

Fan Calibration :Open Fan — Q(CFM)=385.0 X(P).473
Low Flow Plate: 0 holes plugged — Q(CFM)=101.0 X(P).486
4 holes plugged — Q(CFM)= 71.7 X(P).454
6 holes plugged — Q(CFM)= 38.3 X(P).469
7 holes plugged — Q(CFM)= 24.4 X(P).465
8 holes plugged — Q(CFM)= 14.18X(P).477

Test #1

Pressurized ____ Depressurized X (low-flow plate)

P House (Pa)	P Fan (Pa)	# holes plugged	Flow (CFM)
60	65		2750
50	50		2450
40	37		2150
30	25		1750
20	155	0	1200
15	80	0	850
10	60	0	750

AC/H @ 50 Pa 11.96

Equivalent L.A. _____

Effective L.A. _____

Test #2

Pressurized ____ Depressurized X (low-flow plate)

P House (Pa)	P Fan (Pa)	# holes plugged	Flow (CFM)
60	56		2600
50	44		2300
40	30		1900
30	22		1690
20	135	0	1100 ?
15	90	0	900 ?

AC/H @ 50 Pa 11.23

Equivalent L.A. _____

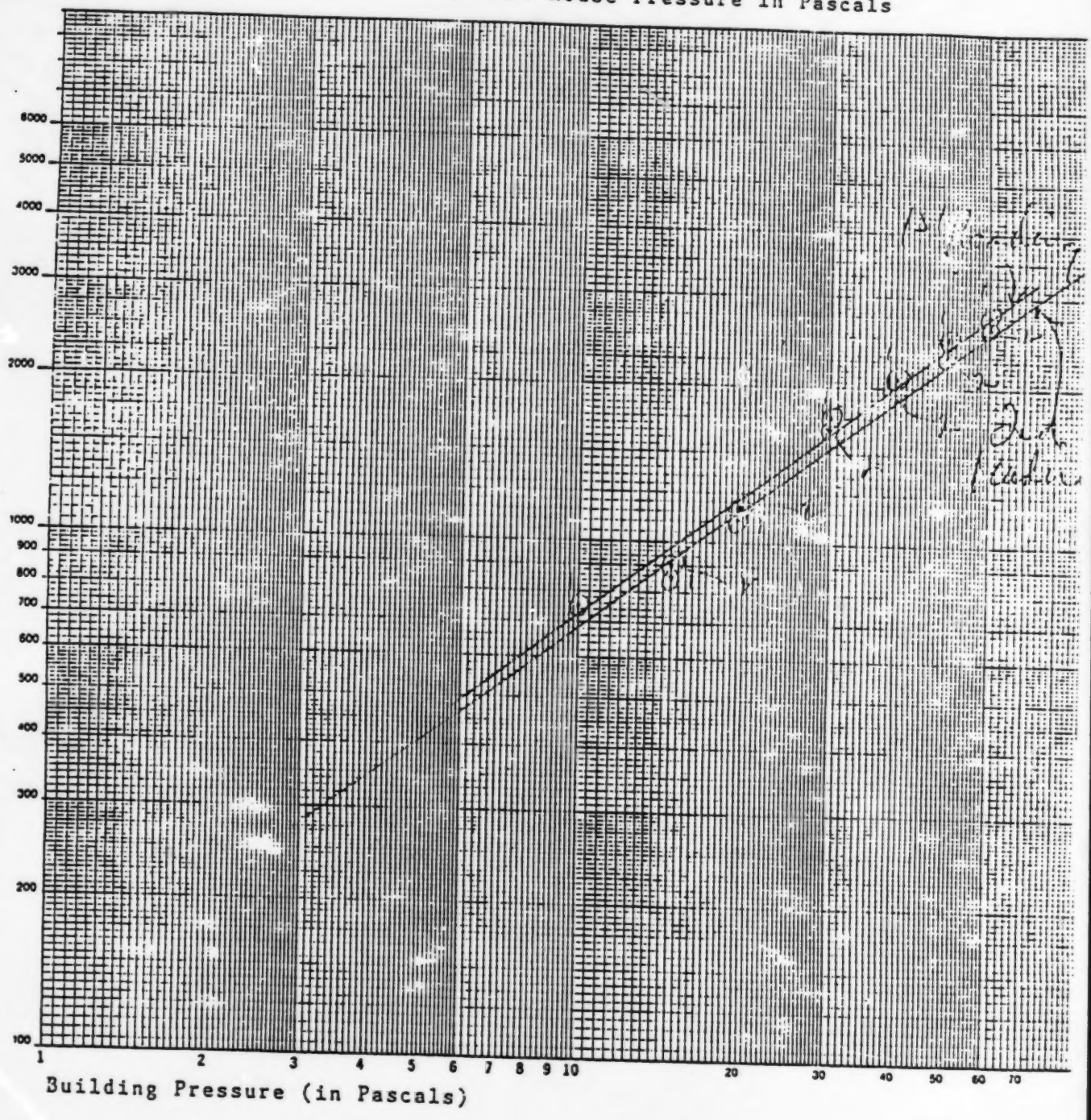
Effective L.A. _____

Comments (Condition of vents and flues during test, major leakage sites, recommendations, etc.)

Test performed by _____.

BUILDING AIR LEAKAGE CURVE

Air Flow in CFM vs. House Pressure in Pascals



MARTIN SAYAZIE : Black Lake Indian Reserve

1. Building type 3 year old 24 x 34 sq. ft. bungalow on grade beam foundation complete with porch on front door.

2. Conditon New construction, although insulation in attic was not complete, drywall not finished properly, occupant had ice form on floor on north wall.

3. Heating System Wood heater - circulatory type, single wall stove pipe and class A chimney, clogged with creosote and also in poor condition, used alot of wood to keep building warm.

4. Window area sq. footage approximately 102 sq. ft.

5. Occupants Two adults and four children.

MONITORING

1. Depressurization Test - see attached sheet.

2. Moisture probe - 8 - 10%

3. Back draft/smoke pencil
   - windows - fair
   - doors - fair
   - baseboards - very poor
   - electrical outlets - very poor
   - wood stove - no back draft.

4. Temperature and humidity

	wet	dry	RH
- crawl space	NA	NA	NA
- living space	59	72	49%
- attic space	62	81	39%
- out door temp.	58	71	46%

5. Occupant Interview - Some cracked window glazing. Occupants said ice formed on floor during winter overnight, cold flow always.

Blower Door Air Leakage Test

Name Sayazie Date August/87

Address Black Lake Outside temp.

Indian Reserve Inside temp.

Wind speed 10 km/hr

House Volume 6528 cu. ft. Surface Area 2560 sq. ft.

Fan Calibration	:Open Fan	Q(CFM)=385.0 X(P).473
Low Flow Plate:	0 holes plugged	Q(CFM)=101.0 X(P).486
	4 holes plugged	Q(CFM)= 71.7 X(P).454
	6 holes plugged	Q(CFM)= 38.3 X(P).469
	7 holes plugged	Q(CFM)= 24.4 X(P).465
	8 holes plugged	Q(CFM)= 14.18X(P).477

Test #1

Pressurized ____ Depressurized X

P House (Pa)	P Fan (Pa)	low-flow plate # holes plugged	Flow (CFM)
50	100	0	950
40	80	0	850
30	50	0	675
20	27	0	500

AC/H @ 50 Pa 8.73

Equivalent L.A.

Effective L.A.

Test #2

Pressurized ____ Depressurized X

P House (Pa)	P Fan (Pa)	low-flow plate # holes plugged	Flow (CFM)
50	57	0	725
40	42	0	625
30	30	0	530
20	52	4	430

AC/H @ 50 Pa 6.66

Equivalent L.A.

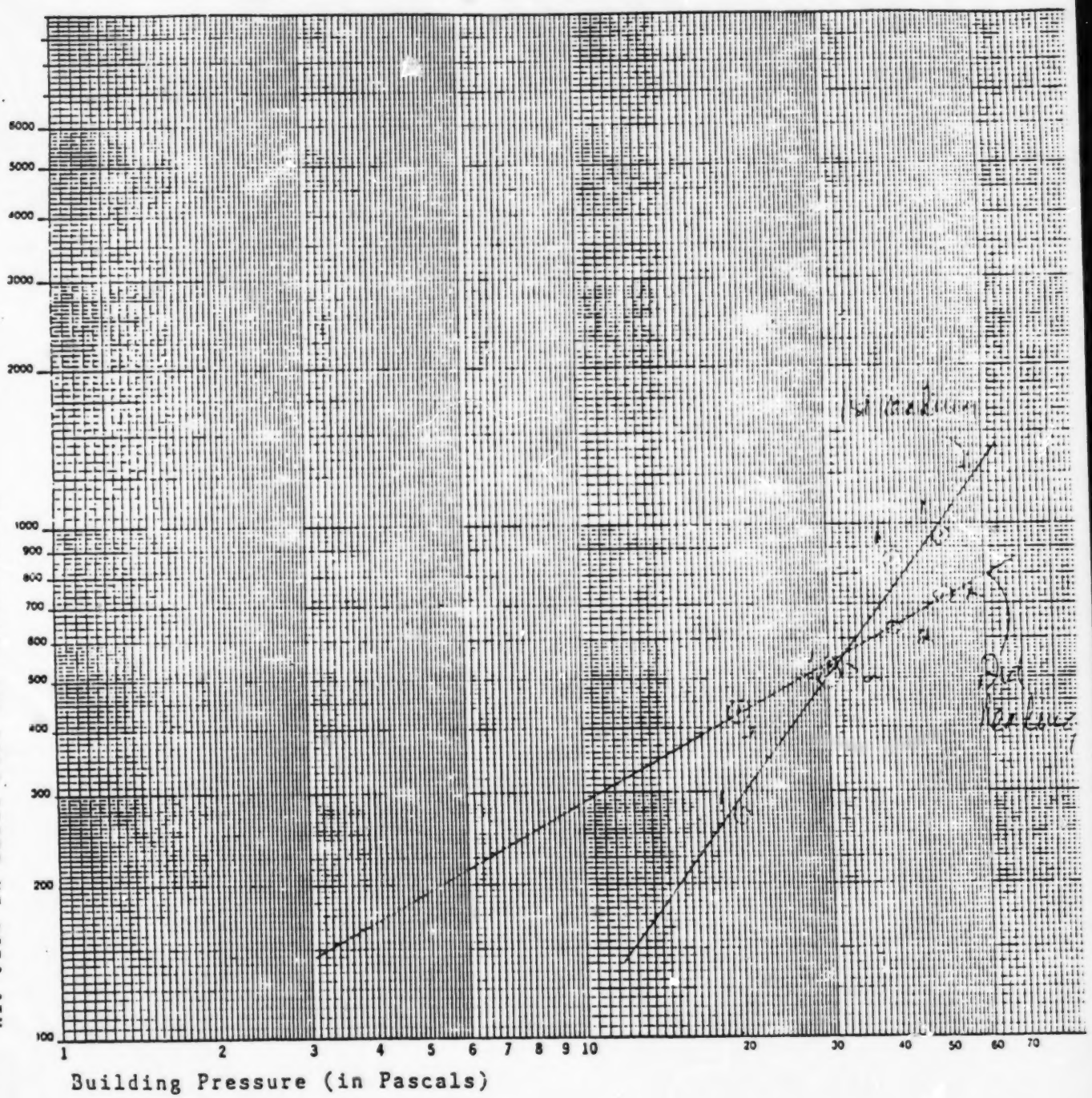
Effective L.A.

Comments (Condition of vents and flues during test, major leakage sites, recommendations, etc.)

Test Performed by .

BUILDING AIR LEAKAGE CURVE

Air Flow in CFM vs. House Pressure in Pascals



Logarithmic 2 x 3 Cycles

EDWARD ISADORE : Fon Du Lac Indian Reserve

1. Building type 14 year old 24 x 32 Bungalow on grade beam, crawl space uninsulated floor joists and foundation. 6144 cu. ft. porch on front door.

2. Condition Occupant carpenter, so in good shape, considering very little upgrades other than insulation and porch addition. Foundation wall cracking and some evidence of heaving, some windows broken.

3. Heating System circulatory type heating system, firebox almost burnt through, single wall stove pipe and class A chimney, creosote built up.

4. Window area sq. footage 97 sq. ft.

5. Occupants two adults and four children.

MONITORING

1. Depressurization Test - see attached sheet.

2. Moisture probe - 8 - 10%

3. Back draft/smoke pencil
   - windows - bad
   - doors - bad
   - baseboards - good
   - electrical outlets - very bad
   - wood stove - no back draft

4. Temperature and humidity

	wet	dry	RH
- crawl space	NA	NA	NA
- living space	59	69	55%
- attic space	59	70	50%
- out door temp.	49	55	70%

5. Occupant Interview - Occupants had complained about not getting any help for any home repairs, especially the wood stove which was in very poor condition.

APPENDIX B
1

Blower Door Air Leakage Test

Name Isadore — Date August/87

Address Fon Du Lac — Outside temp. 55°

Indian Reserve — Inside temp. 69°F

Wind speed 15 km/hr

House Volume 6144 Cu. Ft. — Surface Area 2432 Sq. Ft.

Fan Calibration :Open Fan Q(CFM)=385.0 X(P).473
Low Flow Plate: 0 holes plugged Q(CFM)=101.0 X(P).486
4 holes plugged Q(CFM)= 71.7 X(P).454
6 holes plugged Q(CFM)= 38.3 X(P).469
7 holes plugged Q(CFM)= 24.4 X(P).465
8 holes plugged Q(CFM)= 14.18X(P).477

Test #1 — Test #2

Pressurized ___ Depressurized X (low-flow plate) — Pressurized ___ Depressurized X (low-flow plate)

P House (Pa)	P Fan (Pa)	# holes plugged	Flow (CFM)	P House (Pa)	P Fan (Pa)	# holes plugged	Flow (CFM)
60	37	0	590	60	70	4	490
50	30	0	530	50	50	4	420
40	55	4	450	40	31	4	340
30	40	4	380	30	20	4	280
15	45	6	250	15	30	6	175

AC/H @ 50 Pa 5.17 — AC/H @ 50 Pa 4.10

Equivalent L.A. _____ — Equivalent L.A. _____

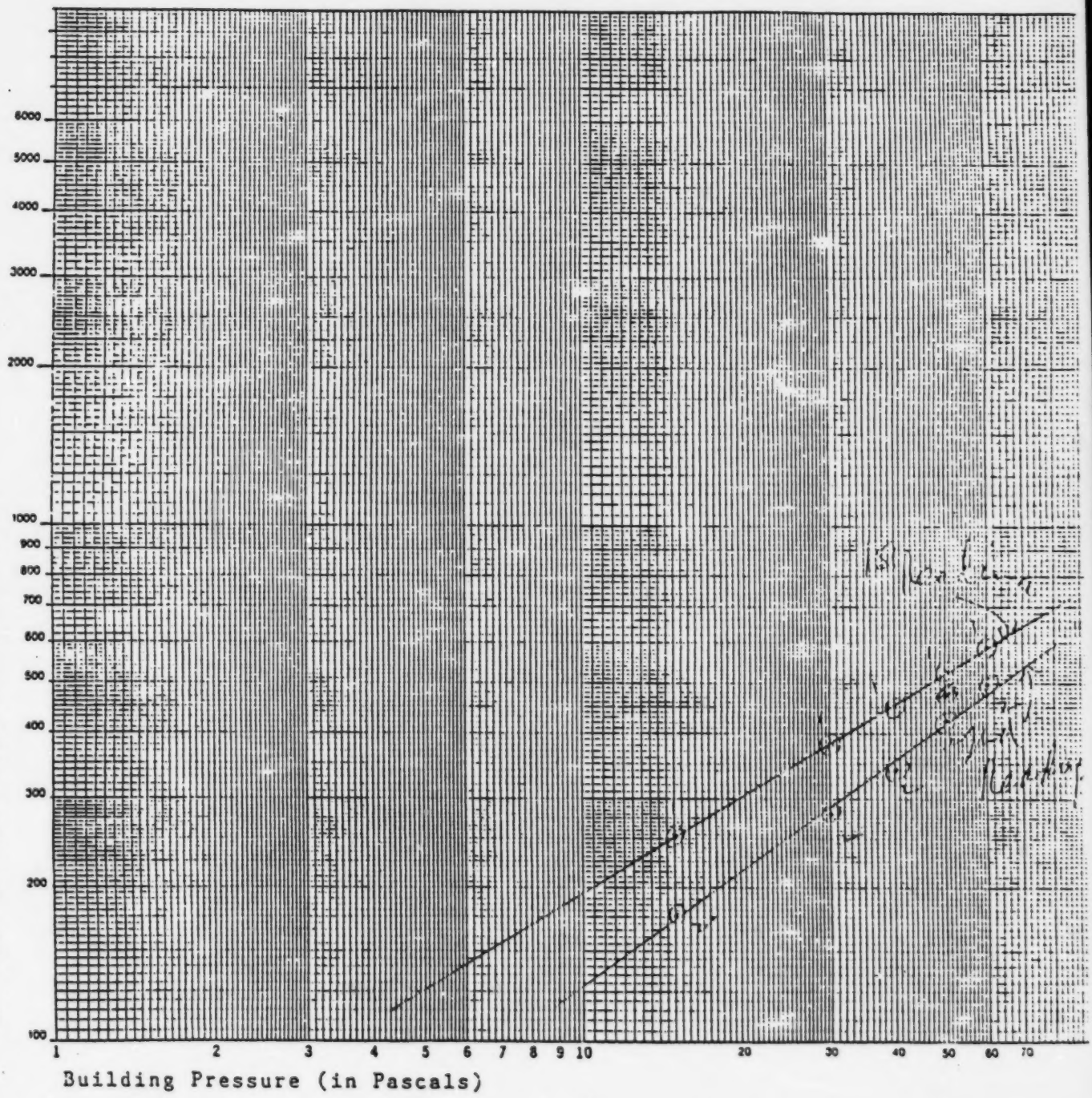
Effective L.A. _____ — Effective L.A. _____

Comments (Condition of vents and flues during test, major leakage sites, recommendations, etc.)

Test performed by _____.

BUILDING AIR LEAKAGE CURVE

Air Flow in CFM vs. House Pressure in Pascals



3. Conclusion

The retrofit work done in the six homes was greatly needed. The measures taken to conserve energy however significant, may have had a greater impact had other areas been addressed also.

i) There was no concern as to sealing off the foundation, in floor joists or grade beams. In the houses with grade beams as foundations there was no insulation, vapour barrier or air barrier to stop air movement. As a result, the air sealing that was done had little effect. A great deal of air movement was coming from the crawl space through various cracks and holes in the floor system.

ii) Another area that could be rectified, in the majority of the homes in the north would be replacement glazing. Nearly every window in each house done had broken windows. These windows could be repaired quite easily by local people using materials that do not break and crack.

I recommend that before any such related projects in the north are done the person in charge of determing what work is to be done consult professionals in the related fields, and have them visit the sites to determine what has to be done.

APPENDIX D

R.A.D. Service and Instruments Ltd.
50 Silver Star Blvd., Unit 208, Scarborough, Ont. M1V 2W4
Tel.: (416) 298-9200 and 298-9220

September 12 1987

CR 9700-11-2

Mr. Peter Piersol
Ontario Research Foundation
Sheridan Park Research Community
Mississauga, Ontario
L5K 1B3

Dear Mr. Piersol,

Re: 1986-87 R-2000 Home Monitoring Program, Sasketchewan
(Report # 79 ·)

Enclosed please find the processing results.

Surveymeter #	House #	WL Radon	FORM
1	Rob Clarke	0.002	.002 KINISTOO - NON STATUS
52	Mary	0.002	.002 SOUTHEND - NON STATUS
54	Oliff Morin	0.001	.001 " - STATUS
54	Isadore	0.001	.001 FONDULAC - STATUS

Dear Mr. Mitchell,

This is a copy of the processing results for detectors which were sent to us on September 3rd. Thank you for sending pumps back for a check.

Yours truly,

H.L. Pai, Ph.D.
President

APPENDIX E

FINAL REPORT

Municipal Air Seal Project

Canada/Nova Scotia Memorandum of Understanding on Conservation and Alternative Energy (MOU)

Prepared by:

Residential Energy Programs
Nova Scotia Department of Mines and Energy
August 1988

1.0 Introduction

This report describes the operation and results of the Municipal Air Seal Project, a joint effort of the Cape Breton Joint Expenditure Board (Jointex), representing eight municipalities in Cape Breton County, Canada Employment and Immigration Commission (CEIC), the Nova Scotia Department of Mines and Energy (NSME), and Energy, Mines and Resources Canada (EMR).

2.0 Background

Air leakage is one of the major sources of heat loss in houses, accounting for up to 40 per cent of total heat loss. To reduce this heat loss, air leakage control work is performed with caulking, weatherstripping, and insulation materials on the inside of the home around windows, doors, sill plates, plumbing stacks, electrical outlets, attic hatches, baseboards and other areas where there is an opening in the building shell through which air can pass.

Air leakage control work has a relatively low material cost (20 per cent of the total cost) but requires a high labour component. Professional contractors are, therefore, forced to charge prices for air sealing which can mean a long payback period for the homeowner.

There are many homes in Nova Scotia where air sealing could reduce heating costs. These homes offer an opportunity to improve energy efficiency. Air leakage control is particularly attractive in older housing where loose construction practices contribute to a large number of potential air leakage paths.

Heating costs are of particular concern to senior citizens, the handicapped and others on fixed income. Moreover, these individuals are often incapable of performing such work on their own, although a great deal of draftproofing can usually be done by the homeowner.

3.0 Objectives

The objectives of the Municipal Air Seal Project were as follows:

1. to encourage greater use of air sealing by municipalities as a part of housing programs for low and fixed income groups,
2. to train unemployed individuals and put them to work draftproofing houses owned by senior citizens and the handicapped on fixed incomes,
3. to air seal 90 rural homes in eight different Nova Scotia municipalities, and

4. to determine, through depressurization testing, the relative air leakage of older, rural housing in Nova Scotia and the reduction in air leakage possible from the application of air sealing techniques.

4.0 Description

The Project consists of the following basic elements:

1. training unemployed individuals,
2. performance of air leakage control work on homes owned by low income residents of Cape Breton County, and
3. depressurization tests on all units before and after air sealing.

The consultant selected for the work was Able Home Improvements, Dominion, N.S.. Able is a member of the National Energy Contractors Association and the Energy Contractors Warranty Corporation and has participated in a variety of government and industry sponsored training programs. Funding was as follows

Cost of materials	-	$ 18,000 (NSME/EMR)
Depressurization testing	-	$ 8,000 (Jointex)
Training and wages	-	$100,000* (CEIC)

* Approximate

Jointex had expressed interest in second and third phases with homeowners paying 50 and 100 per cent of the cost of materials respectively. This additional work was dependent on funding from various agencies and the results of Phase One.

4.1 Training

Training consisted of two weeks of classroom sessions on air sealing and building science. Training materials consisted of National Energy Contractors Association's (NECA) Air Leakage Control Manual, House as a System Manual developed by EMR, sections of the Canadian General Standards Board Insulation Course, information from a manual on depressurization testing published by Retrotec, and audio visual materials produced by government and private industry.

Nineteen employees were hired from a group of 40 unemployed individuals referred by CEIC to Jointex. These were divided into two crews of six and one of seven, with each crew assigned an employee from Able to supervise all air leakage control work and depressurization testing.

Staff were trained in the use of door fan depressurization equipment as well as air leakage control work, customer relations, and the analysis of homes for air leakage locations.

4.2 Selection of Homes

The homes for the project were selected by Jointex from applications on file for Residential Rehabilitation Assistance Program (RRAP) in Cape Breton County. Preference was given to senior citizens with family incomes below $13,000. There are approximately 2,500 applications for RRAP assistance from low income homeowners on file in Cape Breton County and funding to respond to meet only 150 to 200 applicants per year.

Depressurization tests on all units were performed prior to air sealing to ensure that homes which are already relatively airtight were excluded. It was decided at the outset not to seal any homes with an Equivalent Leakage Area (ELA)[1] of less than 1000 sq. cm.. This level is generally recognized by the industry as providing sufficient natural ventilation so as to avoid interior moisture problems in most homes.

The original target was 90 homes at an average cost of $200 in material per house. Approximately 150 homes were tested and 101 sealed. Additional funds for materials for the extra 11 homes were provided by Jointex.

4.3 Project Implementation

Work was performed between January 18 and May 6, 1988.

Information on airtightness was gathered from depressurization tests performed on houses by Able prior to air leakage control work (Appendix 1). Crews sealing the houses repeated these tests in order to become acquainted with the testing procedure and to identify major areas of air leakage. Crews performed a second test after air sealing to determine the reduction in ELA.

5.0 Results

5.1 Labour Per House

The number of hours required for sealing each home was recorded by the supervisor assigned to each crew. The hours were recorded to track the time of the individuals working on the project for payment purposes rather than to carefully document the hours required to seal each house. On average, a crew spent two days on each home.

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[1] ELA is the total area of all gaps and holes in the building envelope and is calculated based on the air flow required to maintain a constant pressure on the building with door fan depressurization test equipment.

These hours included time for pre and post depressurization tests, travel, identification of air leakage paths, and the actual air leakage control work. They also included the time for the supervisor of each crew.

As such, they overestimate the actual time required for the work. Normally only one or two people would be required to perform door fan tests and identify air leakage locations. Part of the time assigned here can also be considered as part of the on-the-job training. Productivity improved as the project progressed. Generally a complete air leakage control job of the type performed on these homes would take a professional crew of two to three individuals a period of one and one-half to three days.

Table 1. Hours of Labour per House

Number of Hours	Number of Houses
48	11
80	10
96	10
104	45
112	2
124	11
no answer	12
TOTAL	101

5.2 House Characteristics

The homes can generally be described as older homes of small or medium size and of one or one and one-half storey. They were virtually all of wood frame construction.

Almost 50 per cent of the homes for which the date of construction is known were built before 1920 (45 of 92). Only three were built in the 1970s and none in either the 1960s or 1980s.

Table 2. Age of House

Year of Construction	Number of Houses
before 1900	9
1900 - 1909	25
1910 - 1919	11
1920 - 1929	13
1930 - 1939	9
1940 - 1949	13
1950 - 1959	9
1960 - 1969	0
1970 - 1979	3
1980 to present	0
no answer	9
TOTAL	101

5.3 Cost of Air Leakage Control Materials

Materials used mainly consisted of spring-loaded door weatherstripping, caulking of various types, v-strip weatherstripping for windows, and rigid foam insulation for blocking large air leakage openings.

Nine of the 92 homes for which material costs are known were sealed with less than $125 worth of materials. These homes were generally smaller than the average or had inaccessible attics. In several cases, homeowners did not wish to have a complete air leakage control job performed because they did not wish parts of the home disturbed.

The ability to perform air leakage control work was somewhat restricted by the $200 available on average for materials. Relatively expensive material such as expanded polystyrene foam insulation could not be used extensively.

Table 3. Cost of Airsealing Materials

Material Cost	Number of Houses
less than $100.00	5
$100.00 - $124.99	4
$125.00 - $149.99	21
$150.00 - $174.99	12
$175.00 - $199.99	13
$200.00 - $224.99	20
more than $225.00	15
no answer	11
TOTAL	101

5.4 Depressurization Testing and Results

The majority of homes selected could be considered excellent candidates for air leakage control work, registering ELAs of greater than 1700 in pre tests. This is equivalent to a hole in the building envelope of 263 sq. in. - a two foot by one foot hole though which air can pass. In 19 cases, ELAs of greater than 3000 were recorded.

Following air leakage control work only 17 of the 100 homes had ELAs above 1700 and only three remained above 3000. Eighty-three per cent registered ELAs of 1700 or less in post air leakage control tests as opposed to 32 per cent before work was carried out.

Table 4. Pre and Post Test Equivalent Leakage Area (ELA)

House ELA (square centimeters)	Before ELA	After ELA
less than 1000	0	23
1000 - 1349	13	33
1350 - 1699	19	27
1700 - 1999	15	6
2000 - 2499	23	5
2500 - 2999	11	3
3000 - 3499	8	2
3500 - 4499	8	1
4500 or greater	3	0
no answer	1	1
TOTAL	101	101

Significant reductions in air leakage were recorded in the majority of homes tested with an average ELA reduction for the 100 homes of 39.3 per cent. Sixty-six per cent registered reductions of 30 per cent or more. A reduction of 50 per cent is considered an excellent result for professional contractors.

It is worth noting that 20 homes had reductions of greater than 50 per cent and seven had reductions of greater than 60 per cent. This indicates the leaky nature of a sizeable number of homes. Only 13 had ELA reductions of less than 20 per cent. Nine of these were homes with starting ELAs of less than 2000 sq cm.

In general, the greater the air leakage area as measured in ELA, the greater the likelihood of a reduction in ELA of 30 per cent or more. Of the 31 homes with starting ELAs of more than 2500 sq. cm, reductions of more than 30 per cent were recorded in 26 cases and reductions of more than 40 per cent were recorded in 19 homes. Reductions in ELA of 30 per cent or more were recorded in slightly less than one-half (19 of 42) homes with starting ELAs of less than 2000 sq. cm.

Air leakage is considered responsible for 40 per cent of a home's heat loss. A rule of thumb for calculating energy savings is to divide the ELA per cent reduction by two to obtain a reasonable estimate of potential energy savings. For example, homes with an ELA reduction of 30 per cent or greater could reasonably expect a reduction in fuel consumption of 15 per cent or more. Sixty-seven homes had ELA reductions of at least 30 per cent The majority of homes (88 of 101) had ELA reductions of 20 per cent or more and should realize measurable fuels savings of more than 10 per cent.

Table 5. Per Cent Reduction ELA

Per Cent	Number of Houses
5.0 - 9.9%	2
10.0 - 14.9%	3
15.0 - 19.9%	8
20.0 - 24.9%	11
25.0 - 29.9%	10
30.0 - 34.9%	18
35.0 - 39.9%	12
40.0 - 49.9%	16
50.0 - 59.9%	13
60.0% and greater	7
no answer	1
TOTAL	101

5.5 Success of Training

The employees hired with CEIC funding to perform the air leakage control work were assessed by the contractor during and at the close of the project. Able Home Improvements, in their summary report on the project dated May 5, 1988, says "of the 19 people trained, we feel that 14 of them are capable of starting their own testing and air-seal business, or applying for a job as experienced air sealers..."

6.0 Conclusions

Based on the foregoing report, a number of conclusions can be drawn about the Municipal Air Seal Project:

1. Older housing stock in Cape Breton is sufficiently leaky to warrant air leakage control work which should result in measurable energy savings. There is a substantial amount of housing to which air leakage control work can be applied provided some assistance is available through government sponsored housing or employment programs.

2. The program trained unemployed individuals in Cape Breton County; at least 14 of whom are capable of performing air leakage control measures in a competent and professional manner.

3. Eight municipalities in Cape Breton County represented by Jointex are now familiar with the benefits of air leakage control work for low income residents.

4. Air leakage control work has a relatively low materials cost component. A figure of $250 to $300 per house would allow more work to be performed than was the case under the current project, result in greater ELA reductions in many homes, and produce additional savings.

5. The use of pre and post depressurization tests on houses will ensure that only units with significant air leakage are sealed and thus limit potential moisture problems created by air leakage control work. Testing also helps crews determine points of air leakage and provides a measure of the success of the work performed.

6. Information on air leakage control should be presented to those responsible for rrap and other programs of assistance for housing in an effort to persuade program authorities to consider air leakage control eligible for funding under their programs.